

# Libo Wu

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## Education

### Texas A&M University

PH.D. CANDIDATE IN MECHANICAL ENGINEERING (TRANSFER STUDENT), GPA: 4.0/4.0

College Station, TX, USA

Aug. 2018 - May. 2021

### Stony Brook University

PH.D. CANDIDATE IN ELECTRICAL AND COMPUTER ENGINEERING, GPA: 3.9/4.0

Stony Brook, NY, USA

Aug. 2015 - Jul. 2018

### University of Science and Technology of China

B.S. IN APPLIED PHYSICS, GPA: 3.71/4.3

Hefei, Anhui, China

Aug. 2011 - Jun. 2015

## Experience

### SLEEPPIR Sensor Network for Human Presence Detection in Residential Buildings

College Station, TX, USA

RESEARCH ASSISTANT, ADVISOR: DR. YA WANG

Dec. 2019 - Present

- Built a wireless sensor network. Each end device contains multiple sensors, including SLEEPPIR presence sensor, motion sensors and temperature/humidity sensor.
- Implemented a hub that receives report from end devices and controls smart thermostats via a cloud service.
- Built the thermal transfer model of indoor environment and found relationship between the signals of sensors to environmental conditions.

### Liquid Crystal Optical Shutter on Passive Infrared Sensor for True Presence Detection

College Station, TX, USA

RESEARCH ASSISTANT, ADVISOR: DR. YA WANG

Aug. 2018 - Present

- Solved the common issue that all commercial motions sensors (PIR sensors) could not detect stationary occupants.
- Created a liquid crystal (LC) infrared shutter that can modulate long-wave infrared radiation with low driving voltage and ultra low power consumption ( $< 0.1\mu\text{W}$ ) [patent pending].
- Manufactured Polymer Dispersed Liquid Crystal (PDLC) infrared shutter with high contrast ratio.
- Developed a synchronized low-energy electronically-chopped PIR sensor for true presence detection by applying the created LC shutter to a PIR sensor and being packaged in an extremely low power embedded system ( $\sim 20\mu\text{W}$ ).
- Designed realistic protocols for experiments which cover most regular daily actions and activities.
- Extracted statistical features and ran machine learning algorithms (NN, SVM, Random Forest, etc.) for presence detection.
- Reached 99.9% accuracy for true presence detection and over 97.7% accuracy for realistic, long-term test.

### Embedded Software Engineer Intern

Marlborough, MA

MARVELL SEMICONDUCTOR, CENTRAL ENGINEERING

Jun. 2020 - Aug. 2020

- Integrated an automated test framework, RobotFramework, to test the behavior of a tool developed by the team.
- Designed over 100 and implement over 40 test cases that cover the functionality test, multi-threading test, performance test, and memory test.
- Wrote helper scripts to assist test automation. Wrote automated test scripts to generate reports.
- Implemented the structures and APIs for a secured communication protocol between a server and an SoC.

### Compressive Sensing for Human Localization Using Single Thermopile Pixel Sensor

College Station, TX, USA

RESEARCH ASSISTANT, ADVISOR: DR. YA WANG

Aug. 2018 - Mar. 2019

- Designed a random binary mask to compress the radiation within the field of view (FOV) [patent pending].
- Integrated one thermopile sensor and rotating optical mask to acquire compressive infrared signals from human.
- Built a physical model that shows the linear relationship among the output signal of sensor, the rotating mask and radiation distributions. Found the relationship could be solved by compressive sensing theory.
- Reconstructed spatial radiation distributions using basis pursuit denoising algorithm to recover localization information.
- Reached over 90% accuracy for localization of indoor the human object with a very low cost (less than \$10).

### Co-Mentor of Senior Design Project: Occupant-centered Light and HVAC Control Using Machine Learning for Human Comfort and Energy Efficiency

College Station, TX, USA

RESEARCH ASSISTANT

Fall 2019

- Guided and managed the team to build a lighting and HVAC control system under \$100 budget.
- Generated a Gantt chart to track the progress of the project. Assigned different tasks based on the skills of the team members.
- Gave guidance of selecting proper hardware (MCU, sensors, wireless communication), design concepts (mechanical and electrical), user-centered product development, and software development (reinforcement learning).

## Passive Infrared Sensor for Indoor Localization and Tracking

Stony Brook, NY, USA

RESEARCH ASSISTANT, ADVISOR: DR. YA WANG

Sept. 2017 - Mar. 2018

- Used a single passive infrared (PIR) and an optical shutter embedded with micro-controller unit (MCU) in the device to analyze the occupancy status of the indoor environment, such as presence, localization, and facial direction.
- Utilized an innovative rotating optical shutter in front of the PIR sensor to modulate the infrared radiation in a nonlinear manner. Built a physical model that shows the relationship between the output signal and the mechanical shutter.
- Extracted two features from the output signals from PIR sensors (peak to peak value, and pulse width).
- Applied machine learning methods (SVM and Neural Network) to improve the performance in predicting and classifying occupancy situations that reached 98% accuracy in localization.
- Extended the functionality of PIR sensors in indoor occupancy detection with high performance, such as human tracking with 0.44 m RSME, localization with 98% accuracy and facial direction detection with 83% accuracy.

## Long-term True Presence Detection Platform

Stony Brook, NY, USA

RESEARCH ASSISTANT, ADVISOR: DR. YA WANG

Jan. 2018 - Jun. 2018

- Utilized the low-power Lavet stepper motor ( $< 10\text{mA}$ ) to drive a mechanical optical shutter on PIR sensors for true presence detection that could detect both stationary and moving occupants **[patent pending]**.
- Built a long-term experiment platform consists of Raspberry Pi, Pi camera, Shutterd PIR sensors and MCU.
- Used computer vision algorithms (YoLo and R-CNN) on videos to extract presence information as groundtruth.
- Reached 97% accuracy for classifying occupied and unoccupied scenes from 31-hour experiment.

## Stony Brook University, Department of ECE

Stony Brook, NY, USA

TEACHING ASSISTANT

Aug. 2015 - Dec. 2017

- Embedded Microprocessor Systems Design (Fall 2016), Digital Systems Design (Spring 2016), Digital Signal Processing: Theory (Fall 2015)

## Publications

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### JOURNAL PUBLICATIONS

- **Libo Wu**, Zhangjie Chen, and Ya Wang, "An Adaptive Threshold Approach for Indoor Occupancy Detection with SLEEPIR Sensor Network in Practical Environments", *will submit to IEEE Sensors Letters*, 2021.
- **Libo Wu** and Ya Wang, "Study the Characteristics of Polymer Dispersed Liquid Crystal Infrared Shutter on PIR Sensors", *will submit to IEEE Sensors Journal*, 2021.
- **Libo Wu** and Ya Wang, "True Occupancy Detection Enabled by the SLEEPIR Sensor and Machine Learning", *IEEE Sensors Journal*, *under review*, 2021.
- **Libo Wu**, Fangwang Gou, Shin-Tson Wu and Ya Wang, "SLEEPIR: Synchronized Low-Energy Electronically-Chopped PIR Sensor for True Presence Detection", *IEEE Sensors Letters*, 4(3), pp. 1-4, 2020.
- **Libo Wu**, and Ya Wang, "Compressive Sensing Based Indoor Occupancy Positioning Using A Single Thermopile Point Detector with a Coded Binary Mask", *IEEE Sensors Letters*, 3(12), pp. 1-4, 2019.
- **Libo Wu**, Ya Wang and Haili Liu, "Detection and Localization of Individuals by Monitoring Nonlinear Energy Flow of a Shuttered Passive Infrared Sensor", *IEEE Sensors Journal*, 18(21), pp. 8656-8666, 2018.
- **Libo Wu** and Ya Wang, "A Low Power Electric-Mechanical Driving Approach for True Occupancy Detection Using a Shuttered Passive Infrared Sensor", *IEEE Sensors Journal*, 19(1), pp. 47-57, 2018.

### CONFERENCE PROCEEDINGS

- **Libo Wu** and Ya Wang, "True Presence Detection via Passive Infrared Sensor Network Using Liquid Crystal Infrared Shutters", *ASME SMASIS conference*, 2020.
- **Libo Wu** and Ya Wang, "Compressive Sensing Based Indoor Human Positioning Using A Single Thermopile Point Detector", *12th International Workshop on Structural Health Monitoring, September 10-12, 2019, Stanford, California, USA*.
- **Libo Wu** and Ya Wang, "Shuttered Passive Infrared Sensor for Occupancy Detection: Exploring A Low Power Electro-Mechanical Driving Approach", *ASME SMASIS conference*, 2018 (Oral presentation).

## Patents

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- **Libo Wu** and Ya Wang, "Shuttered Passive Infrared Sensor Apparatus with A Low Power LWIR Liquid Crystal Optical Modulator for Stationary and Moving Occupancy Detection", *U.S. Patent Application No. 62/880,058*, July 29, 2019.
- **Libo Wu** and Ya Wang, "A Single Thermopile Point Sensor Apparatus with A Set of Coding Masks (Compressive Sensing Matrix) for Indoor Human Positioning", *U.S. Patent Application No. 62/863,823*, June 19, 2019.
- **Libo Wu** and Ya Wang, "Shuttered Passive Infrared Sensor Apparatus with A Low Power Lavet Motor Driving Approach for Stationary and Moving Occupancy Detection", *U.S. Patent Application No. 62/863,808*, June 19, 2019.

## Skills

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**Programming** Embedded C, Python, C/C++, Matlab, Assembler,  $\LaTeX$

**Technical Skills** ARM Cortex-M microcontroller development, RobotFramework, RTOS, SolidWorks, Machine learning, ML frameworks (Tensorflow, Keras), Wireless Communication (BLE, Zigbee), PCB design, Circuit design

## Certification

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**Online Course Certificate** Machine Learning (Couseara), Deep Learning Specialization (Couseara), Mastering RTOS: Hands on FreeRTOS (Udemy), Mastering Microcontroller with Driver Development (Udemy)

## Honors & Awards

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- 2019 **Graduate Student Travel Award**, J. Mike Walker '66 Department of Mechanical Engineering
- 2019 **Graduate Excellence Scholarship**, J. Mike Walker '66 Department of Mechanical Engineering
- 2013 **Bronze Medalist**, Outstanding Undergraduate Scholarship